

PERKAL'SKIY, V.A.

~~Simple demonstration~~ of the reversal of the sodium spectral line.  
Izv.vys.ucheb.zav.; fiz. no.6:172-173 '59. (MIRA 13:6)

1. Sibirskiy fiziko-tekhnicheskoy institut pri Tomskom gosuniver-  
sitete imeni V.V.Kuybysheva.  
(Sodium--Spectra)

SOV/47-59-3-19/53

22(1)

AUTHOR: Markal'skiy V.A. (Tomsk)

TITLE: Demonstration of **Standing** Sound Waves

PERIODICAL: Fizika v shkole, 1959, Nr 3, p 71 (USSR)

ABSTRACT: In the study of the subject "Sound", the author recommends the demonstration of **standing** sound waves, which can be obtained by the use of the GZ-1 sound generator and a loudspeaker from the substandard motion-picture projector "Ukraina", which contains two dynamic loudspeakers. Therefore, within the limits of the central pencil of rays a nearly plane sound wave can be obtained. The loudspeaker has to be installed at the end of the physics workshop in the passage between the tables and must be connected to the sound generator. The frequency will be nearly 250 cycles. Changing it within certain limits gives the maximum effect. The voltage amplitude of

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SOV/47-59-3-19-63

Demonstration of **Standing** Sound Waves

the generator should not be too large. The sound waves propagated through the passage are reflected from the blackboard, and result in **standing** waves which the audience can detect. In the units the noise is very weak, which reveals itself in particular at an approach to the unit next to the loudspeaker. If the sounds are directed not along, but across the room, zones of noise and zones of quiet can be distinguished. They are due to interferences of the two sources (the dynamic loudspeakers).

Card 1 -

PERKAL'SKIY, V.A. (Tomsk)

Forgotten experiment pertaining to the theory of the visual  
distinction of colors. Fiz. v shkole 20 no.2:77 Mr-Ap '60.  
(MIRA 14:5)

(Color sense)

GAMAN, V.I.; FERKAL'SKIY, V.A.; KALLESTINOV, G.V.

Effect of a strong field in germanium p-n junctions. Izv.vys.ucheb.  
zav.;fiz. no.2:3-9 '60. (MIRA 13:8)

1. Sibirskiy fiziko-tekhnicheskoy institut pri Tomskom gosuniversitete  
im. V.V. Kuybysheva. (Electric fields)  
(Semiconductors)

PERIAL'SKIY, V.A.

Demonstration of the energy distribution of electrons by means of  
thermionic emission. Izv.vys.ucheb.zav.;fiz. no:2:233-234 '60.  
(MIRA 13:8)

1. Sibirskiy fiziko-tekhnicheskoy institut pri Tomskom gosuniversitete  
im. V.V.Knybysheva. (Thermionic emission)  
(Electrons)

PERKAL'SKIY, V.A.

Demonstration of damped and coupled electromagnetic vibrations.  
Izv. vys. ucheb. zav.; fiz. no.3:160-162 '58. (MIRA 11:9)

1. Sibirskiy fiziko-tekhnicheskii institut pri Tomskom gosuni-  
versitete imeni V.V. Kuybysheva.  
(Electric waves)

PERKAL'SKIY, L.A.

Demonstration of Franck-Hertz experiment. Izv. vys. ucheb.  
sav.; fiz. no.3:163-164 '58. (MIRA 11:9)  
(Electric discharges through gases)

PERKAL'SKIY, V.A.

Demonstrating damped electric oscillations. Fiz. v shkole 17 no.6:  
60-61 N-D '57. (MIRA 10:12)

1. Sibirskiy fiziko-tehnicheskiy institut, Tomsk.  
(Oscillators, Electric)

PERKANOV, B., and ABOLISHIN, P.

"Certain Questions on Anti-Atomic Defense of Ships," a chapter from the book Problems in the Utilization of Atomic Energy, the second revised edition of a collection of articles, published in 1956, Moscow, USSR

PERKANOV, B.

"Some Questions on Antiatomic Defense of Ships," by Captain P. Abclishin and Engineer-Captain-Lieutenant B. Perkanov, Problemy Ispol'zovaniya Atomnoy Energii (Problems of the use of Atomic Energy), Moscow, Voennoye Izdatel'stvo Ministerstva Oborony Soyuza SSR, 1956, pp 481-499

The following are discussed: characteristics of air, surface, and underwater bursts of atomic bombs; the effect of shock wave, light radiation, penetrating radiation, and radioactive contamination on ships and personnel; and proposed protective design changes in ships, such as reinforcement, hermetic sealing, remote control apparatus, and sprinkler systems. Numerous references are made to the damaging effects on ships of the atomic explosion at Bikini and to data appearing in the "foreign press." (U)

Sum in 1951

PERKANOV, B., and ABOLISHIN, P.

"Some Questions of the Anti-Atomic Defense of Ships" and  
artical in the publication Problems of the Use of Atomic Energy. October, 1956.

Moscow

1. PERKARSKIY, S.; FEL'DMAN, Kh.
2. USSR (600)
4. Radio - Stations
7. State All-Union standard for amplifiers for radio rebroadcasting stations. Radio No. 1, 1953.

9. Monthly List of Russian Accessions. Library of Congress. May 1953. Unclassified.

PERKAL, J.

A stochastic description of the renal threshold excretion. Bul  
Ac Pol. mat 10 no.1:35-37 '62.

1. Instytut Matematyczny, Polska Akademia Nauk, Warszawa. Presented  
by E. Marczewski.

KUPERSHTOK, K.I.; PERKAS, Kh.D.; BRIILEVA, L.G.

Determination of the acidity of pickle baths in the presence of iron.  
Zav. lab. 31 no.8:947 '65. (MIRA 18:9)

1. Nikopol'skiy yuzhnostrubnyy zavod.

KUPERSHTOK, K.I.; PERKAS, Kh.D.; VIT KO, N.D.

Determination of fluorine in a nitric-hydrofluoric pickling  
solution. Zav.lab. 28 no.4:416-417 '62. (M.I.D. 15:5)

1. Nikopol'skiy Yuzhnotrubby metalurgicheskiy zavod.  
(Fluorine Analysis)

S/0129/64/000/002/0002/0008

ACCESSION NR: AP4012426

AUTHORS: Kardonskiy, V. M.; Kurdyumov, G. V.; Perkas, M. D.

TITLE: Influence of size and form of cementite particles on structure and properties of steel after deformation

SOURCE: Metalloved. 1 term. obrab. metallov, no. 2, 1964, 2-8, plus insert bet. pp. 24 & 25

TOPIC TAGS: steel properties, cementite particles plastic flow, lamellar cementite, cementite, cementite crystal

ABSTRACT: The purpose of the present work is to study the influence of cementite form (lamellar or globular) on the formation of the fine steel structure during plastic flow (including dislocation). Steels with a carbon content of 0.1, 0.4 and 1% were studied. After various degrees of deformation the steel structure was studied by X-ray and electron-microscope methods. After deformation, the shape of the cementite substantially influences the structure of steel and its mechanical properties. During plastic flow of steel with globular cementite, the fine structure of ferrite is similar to the

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ACCESSION NR: AP4012426

structure of deformed carbon-free iron, and their dislocation structures are similar. The shape, size, and internal structure of cementite crystals are only slightly changed in the process of plastic flow. It was determined that the work hardening of steel during deformation is not related to carbon content and corresponds to the increase in strength of carbon-free iron. Lamellar, unlike globular cementite, contributes to the derivation of a more dispersed ferrite substructure during deformation. Plastic flow of cementite crystals also occurs, resulting in the formation of a fine structure. Most of the eutectoid grains are crushed in the deformation process, with lamination disappearing. In those areas where lamination is maintained, there is a thinning of cementite crystals and a decrease in inter-lamellar spacing. The effect is more clearly expressed than the dispersed eutectoid before deformation. Increased eutectoid dispersion contributes to the derivation of a more developed fine structure of ferrite and cementite. Orig. art. has: 8 Figures, 1 Table.

ASSOCIATION: T<sub>s</sub>NIICHM

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Card

ACCESSION NR: AP4012426

SUBMITTED: 00

DATE ACQ: 03Mar64

ENCL: 00

SUB CODE: ML

NR REF SOV: 005

OTHER: 003

Card 3/3

KARDONSKIY, V.M.; PERKAS, M.D.

Unordering of hardened and plastically deformed iron. Fiz. met.  
i metalloved. 12 no.6:913-915 D '61. (MIRA 16:11)

1. Institut metallovedeniya i fiziki metallov.

ACCESSION NR: AP4028998

S/0126/64/017/003/0400/0407

AUTHORS: Perkas, M. D.; Snitsar', V. I.

TITLE: The influence of alloying elements on martensite hardness in heated iron-nickel alloys

SOURCE: Fizika metallov i metallovedeniye, v. 17, no. 3, 1964, 400-407

TOPIC TAGS: iron-nickel alloy, martensite, alloying element, Ti, Al, Mn, Nb, Zr, Mo, martensite hardness, martensite aging, metal structure, Vickers hardness, phase composition, elasticity modulus

ABSTRACT: The influence on martensite aging of Ti, Al, Mn, Nb, Zr, and Mo additions to iron-nickel alloys was investigated. Experimental 5-kg ingots containing 1.0-2.0 wt % of alloying elements were cast and forged into rods 20 x 10 mm and into disks 14 mm in diameter. Martensitic structure was produced by air cooling of specimens. Their hardness (Vickers) and modulus of elasticity were determined after tempering and aging at various temperatures. The effect of adding alloying elements to material with 16.5-18.0% Ni at various temperatures is shown in Fig. 1 of the Enclosures. The same effect produced on material with 8.0%

Corq 1/8 2

ACCESSION NR: AP4028998

Ni by addition of Ti and Al (separately and jointly) may be seen in Fig. 2. It was determined that martensite hardening increases with the increase of nickel content and disappears below 2.0% Ni. Joint addition of several elements serves to strengthen the  $\alpha$ -phase. The process of hardening ceases at about 500C and is reversed at higher temperatures. The variation of the  $\alpha$ -phase strength was found to be related to the number of defects in the original structure, and increased with the number of defects. The modulus of elasticity was determined by measuring the changes in the resonance frequencies of longitudinal oscillations. The changes in the modulus became apparent at 350C, with the maximum being reached at 500C (see Fig. 3 of the Enclosures). For comparison, Fig. 3 also shows the change of hardness with temperature. Orig. art. has: 9 graphs.

ASSOCIATION: Institut metallovedeniya i fiziki metallov TsNIICHM (Institute of Metallurgy and Physics of Metals, TsNIICHM)

SUBMITTED: 13May63

DATE ACQ: 27Apr64

ENCL: 03

SUB CODE: ML, PH

NO REF SOV: 003

OTHER: 004

Card 2/2

PERKAS, M.D.

KAMINSKIY, E.Z., kand.fiz.-mat.nauk; PERKAS, M.D.

Studying the structure of hardened low-carbon steel. Probl.metalloved.  
1 fiz. met. no.[1]:211-224 '49. (MIRA 11:4)

1.Laboratoriya fazovykh prevrashcheniy Tsentral'nogo nauchno-  
issledovatel'skogo instituta chernoy metallurgii.  
(Steel--Metallography)

PERKAS, M. D.

"Crystalline Structure of Hardened Low-Carbon Steels and the Effect of Alloying Elements on the Decomposition of Martensite." Sub 11 Dec 51, Inst of Metallurgy imen:  
A. A. Baykov, Acad Sci USSR

Dissertations presented for science and engineering degrees in Moscow during 1951.

SO: Sum. No. 480, 9 May 55

*Perkas M.D.*  
KURDYUMOV, G.V., PERKAS, M.D.

Effect of alloying elements on the stability of martensite during  
tempering. Probl. metalloved. i fiz. met. no. 2:153-166 '51.  
(MIRA 11:4)

1. Chlen-korrespondent AN SSSR (for Kurdyumov).  
(Steel alloys--Metallography) (Tempering)

PERKAS, M.D.

KURDYUMOV, G.V.; PERKAS, M.D.

Mechanism of austenite dissociation in the intermediate temperature range. Probl. metalloved. i fiz. met. no.2:167-175 '51. (MIRA 11:4)

1. Galen-korrespondent AN SSSR (for Kurdyumov).  
(Steel alloys--Metallography) (Austenite)

PERKAS, M.P.

USSR

Formation of carbide in the alloy steels during tempering at higher temperatures. G. V. Kurdyumov and M. D. Perkas. Doklady Akad. Nauk S.S.S.R. 87, 41-3 (1982). Two types of the alloy steels contg.: (a) C 0.10%, V 1.40, Mn 1.48; and (b) C 0.10, Mo 2.14, were hardened at temp. of 1240° and 1250°, resp., and then tempered. Their hardness (34-36 R<sub>c</sub>) after tempering up to 450°-500° was not changed. Further increasing the temp. results in increasing the hardness (secondary hardness) up to 37-40 R<sub>c</sub> (at 550°-600°) upon which a sharp drop of the hardness follows. The expl. data shows that martensite of these steels has no noticeable decomposition at tempering below 500°, but at the higher temp. the tempering causes the martensite decomposition and formation of special carbides (M<sub>23</sub>C<sub>6</sub> and VC). W. Farafanov

PERKAS, M.D.

Journal of the Iron and Steel Institute  
Vol. 176  
Apr. 1954  
Metallography

On the State of Martensite Crystals of Hardened Low-Carbon Steels. G. V. Kurdymov, M. D. Perkas, and A. E. Shamov. (Doklady Akademii Nauk SSSR, 1953, 92, (5), 955-957). [In Russian]. The state of martensite in a series of low-carbon steels (quenched from 1000-1050° C. in a solution of sodium hydroxide at 0° C.) was investigated by determining the width of the (211) line in chromium radiation, the hardness, and the coercive force. An increase in carbon content leads to a continuous increase of all three quantities, indicating an increasing amount of carbon in solid solution. Concerning the influence of manganese content on the width of the line (211) it was found that, in all alloys, the carbon content of martensite was the same and that the carbon was retained in solid solution. It is concluded from the data obtained that, during the rapid quenching of carbon steel containing 0.1% of carbon, martensite is not able to decompose during cooling and the carbon remains in solution. This conclusion is valid for steels with carbon < 0.1%. The main condition for the retention of all the carbon in a solid solution is a high quenching speed.—V. O.

Evaluation: B-78539, 8 Sep 54

PERKAS, M.D.

KURDYUMOV, G.V., akademik; PERKAS, M.D., kand. tekhn. nauk; SHANOV, A.Ye., kand.  
fiz.-mat. nauk

State of martensite crystals in hardened commercial iron and low-  
carbon steel. Probl. metalloved. i fiz. met. no. 4:228-238 '55.  
(Metal crystals) (Martensite) (MIRA 11:4)

PEIKAS, M.D.

Roentgenographic method for determining carbon in the cemented zone.  
Zav. lab 22 no.9:1061-1063 '56. (MLRA 9:12)

1. Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii.  
(X rays--Industrial applications) (Carbon--Analysis)  
(Steel--Analysis)

PERKAS, M. D.

Determination of the depth of the decarbonized layer by  
the X-ray method. M. D. Perkaz. *Zoro-fishaya Lab. 22,*  
1454-0011000. ~~By using the~~ By using the  
method described above, the quantity of C in the de-  
carbonized layer was detd. J. Rovtar Leach 11

PERKAS, M.D.

X-ray method for determining the depth of a decarbonized layer. Zav. lab. 22 no.12:1458-1460 '56. (MLBA 10:2)

1. Tsentral'nyy nauchno-issledovatel'skiy institut Chernoy metallurgii.  
(X-rays) (Steel--Analysis)

PERKAS, M. D

CARD 1 / 2

PA - 1857

SUBJECT USSR / PHYSICS  
AUTHOR KUDRJUMOV, G.V., PERKAS, M.D.  
TITLE On the Hardening of Hot Alloyed Carbonless Iron.  
PERIODICAL Dokl. Akad. Nauk, 111, fasc. 4, 818-820 (1956)  
Issued: 1 / 1957

At first some previous works are discussed. The impossibility of hardening carbonless iron, i.e. the impossibility of the production and the growth of the germs of the  $\alpha$ -phase above the martensite point is due to a disturbance of the crystal structure of austenite, and consequently by the high mobility of the atoms. Heating up to  $1000^{\circ}$  and more diminishes the production velocity of the  $\alpha$ -phase in a higher range of transformation temperatures and makes undercooling of the austenite down to the domain of martensite transformation possible. If these assumptions are correct the possibility of hardening pure iron by increasing the temperature of heating will increase. For this purpose a heating temperature of more than  $1100^{\circ}$  is taken, because in that case the dependence of the diffusion coefficient on temperature takes a normal course.

The iron examined in this case had the following chemical composition:  
0.01% C; 0.05% Mn; 0.02% Si; 0.008% P; 0.03% S; 0.041%  $O_2$ ; 0.009%  $H_2$ ;  
0.004%  $H_2$ . The samples consisted of  $20 \times 10 \times 1$  mm plates. The samples were chilled in a 10% aqueous NaOH solution at  $5^{\circ}$ . The state of the iron after various forms of processing was estimated by measuring the hardness (according to HICKERS) and the breadth of roentgen-interferences. For the samples

GOLUBKOV, V.M.; IL'INA, V.A.; KRITSKAYA, V.K.; KURDYUMOV, G.V.; PERKAS,  
M.D.

Studying physical factors determining the hardening of alloyed  
iron. Fiz. met. i metalloved. 5 no. 3:465-483 '57. (MIRA 11:7)

1. Institut metallovedeniya i fiziki metallov Tsentral'nogo  
nauchno-issledovatel'skogo instituta chernoy metallurgii.

(Iron alloys--Hardening)  
(Deformations(Mechanics))

PERKAS, M. D., Cand. Tech. Sci.;

"An investigation of the physical factors determining the strengthening of alloy iron," with Golubkov, V. M., Il'ina, V. A., Kritskaya, V. K., Cand. Phys. and Math. Sci.; Kurdyumov, G. V., Academician, page 433

In book Problems of Physical Metallurgy. Moscow, Metallurgizdat, 1971, 200 p. (See: Sbornik trudov, v. 2)

The articles in the book present results of investigations conducted by the issuing body, Inst. of Physical Metallurgy, a part of the Cent. Sci. Res. Inst. of Ferrous Metallurgy, located in Dnepropetrovsk. The investigations were concerned with phase transformations in alloys, strengthening and softening processes, diffusion processes (studied with the aid of radioactive isotopes), and certain other questions.

127-5 127-5  
AUTHOR: Perkas, M.D., Engineer

127-5 127-5

TITLE: Study of the Hardening and Softening of Manganese Alloyed Iron (Izucheniye uprechneniya i razuprechneniya spetsialnykh legirovannogo margants'em)

PERIODICAL: Metallovedeniye i Obrabotka Metallov, 1992, No 5, pp 8-13 (USSR)

ABSTRACT: In earlier work, other Soviet authors (Refs. 1-5) studied the hardening and the softening of iron, alloyed with manganese, paying attention mainly to the mechanical and physical characteristics. In this paper a comparison is made of the macroscopic properties (hardness, yield point) and the characteristic of the fine structure of manganese alloyed ferrite after various methods of hardening and softening during heating. In the experiments a binary alloy was used which was produced by smelting in a high frequency 50 KVA furnace and contained 0.02% C, 2.9% Mn, 0.02% Si, 0.017% S, 0.001% P. After homogenisation annealing at 1100°C for twenty hours, the ingot was forged which was followed by cold rolling with a total reduction of 60%. The thus produced strips were cut into flat specimens for X-ray analysis and hardness measurement and also into specimens for micro-mechanical tests. The specimens were hardened

Card 1/3

Study of the Hardening and Softening of Manganese Alloys Iron. 129-54-5-3/17

from 1000 to 1050°C in a 10% solution of NaOH at 5°C. After hardening and plastic deformation in the cold state, the specimens were tempered in a tubular furnace in vacuum at temperatures up to 350°C in steps of 50 and 100°C respectively with holding times of two hours. The increase in hardness due to cold working as well as the increase in hardness due to hardening by heat treatment were studied and also the influence of various degrees of deformation on the characteristic of the fine structure. On the basis of the results, which are entered in tables, the following conclusions are arrived at:

1. Manganese alloyed iron hardens more than non-alloyed iron in the case of cold working (with a reduction of 10%);
2. Alloying of the iron with manganese influences the process of the softening of the ferrite during heating; decrease in the values  $\Delta a/a$ ,  $H_v$  and  $\sigma_s$  takes place in the directions of the regions of coherent deformation in a binary Fe-Mn alloy takes place at higher temperatures than in the case of non-alloyed iron. When heating the temperature range in which the softening takes place in the characteristics of the fine structure.

Card 2/3

Study of the Hardening and Softening of Iron-Manganese Alloys

( $\Delta\sigma/\sigma$  and  $D$ ) does not coincide with the temperature range in which the changes take place in the mechanical properties ( $\sigma_y$  and  $H_V$ ).

3. An increase in the strength of the deformed and hardened specimens after heating at 700-750°C and subsequent cooling is due to the fact that the ferrite forming at these temperatures is enriched with carbon and during the subsequent slow cooling it transforms into an  $\alpha$ -phase according to the eutectoid mechanism.

4. Investigation on the Fe-Mn alloy of the influence of various reductions in the cold state on the change of the characteristics of the fine structure and of the mechanical properties leads to the conclusion that the formation of finer blocks is one of the factors determining the hardening of ferrite during plastic deformation.

Card 3/3 There are 5 figures and 6 references, all of which are Soviet.

ASSOCIATION: TONIICHER et

AVAILABLE: Library of Congress.

1. Iron-manganese alloys-Hardening
2. Iron-manganese alloys-Heat treatment
3. Iron-manganese alloys-Structural analysis
4. Iron-manganese alloys-Transformations

L 40830-65 ENT(m)/EPA(s)-2/EWP(w)/EWA(d)/I/EWP(t)/EPA(bb)-2/EWP(z)/EWP(b)/EWA(c)  
 Pad/Pt-10 IJP(c) JD/HM  
 ACCESSION NR: AP5006337 8/0126/65/019/002/0293/0296

AUTHOR: Kardonskiy, V. M.; Perikas, H. D.

TITLE: Structural changes during maraging in Fe-Ni-Ti alloys

SOURCE: Fizika metallov i metallovedeniye, v. 19, no. 2, 1965, 293-296

TOPIC TAGS: maraging, titanium alloy, nickel alloy, hardening, phase transformation intermetalloid

ABSTRACT: The purpose of this study was to show what changes in the structure are associated with martensite hardening in the 350-600° C range in iron-nickel alloys containing titanium. Specimens in the form of thin films prepared by electrolysis were studied using a UEMV-100 electron microscope with accelerating voltage of 100 kv. An alloy containing 8% Ni and 1.5% Ti, in which direct transformation begins at 400° C and reverse  $\alpha \rightarrow \gamma$  transformation takes place above 700° C, was selected for the study. The original hardness of the martensite (240 HV units) remains unchanged up to 350° C. Beginning at 400° C there is a sharp increase in hardness reaching a maximum (at 500° C) of 420 HV units. With a further increase in temperature the hardness is reduced and at 700° C reaches its original value. After

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ACCESSION NR: AP5006337

cooling from 1000° C to room temperature the alloy structure consists of a large number of disoriented martensite crystals with a high dislocation density. In specimens heated for one hour at 400-500° C there are no noticeable changes in the martensite structure with the exception of a reduction in the dislocation density; however the hardness is increased at 500° C shows an increment of 180 HV units. After protracted heating (9 hours) at 500° C, segregations are observable in certain portions of the martensite in the form of thin platelets approximately 30 Å thick and up to 150 Å long. The boundaries between the particles and the matrix are strongly eroded, it must be presumed, because of the presence of elastic deformation fields; hence the true sizes of the segregations are probably much less than the figures given above. After 100 hours holding at 500° C, curved segregations 50-90 Å in size appear, some of which are uniformly distributed in the form of individual chains (platelets) up to 400 Å long. Further heating (600° C for 1 hour) leads to an increase in the size of the segregations, their form becomes more equiaxial, and the largest size is approximately 150 Å. In some cases the segregations are situated along dislocation lines. After heating to 670° C the segregations become almost spherical, their average diameter is 300 Å, and the average distance between them is increased. After heating above the temperature for initiation of reverse  $\alpha \rightarrow \gamma$  transformation (730° C for 10 minutes) no particles

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L 40830-65

ACCESSION NR: AP5006337

of the separated phase were observed. Evidently they are rapidly dissolved in the  $\gamma$ -phase. Electron microscope study of a specimen aged at  $670^{\circ}\text{C}$  and then at  $600^{\circ}\text{C}$  for 40 minutes actually indicated that there are fine particles ( $50\text{ \AA}$ ) formed at  $600^{\circ}\text{C}$  in addition to large particles measuring approximately  $400\text{ \AA}$  which are formed during high temperature aging. The Fe-Ni-Ti diagram shows that one can expect (iron angle of the diagram) the isolation of an intermetalloid of the  $(\text{Fe, Ni})_2\text{Ti}$  type in the  $400\text{--}700^{\circ}\text{C}$  range having a hexagonal lattice (for  $\text{Fe}_2\text{Ti}$ :  $a = 4.769$ ,  $c = 7.745$ ). Nickel with titanium in the system Fe-Ni-Ti forms two phases:  $\text{Ni}_3\text{Ti}$  (hexagonal lattice,  $a = 5.093$  and  $c = 8.276$ ) and  $\text{NiTi}$  (CsCl type,  $a = 2.99\text{--}3.013$ ). From the results of measurement of the interplanar distances the conclusion can be made that the phase isolated by aging is an  $\text{NiTi}$  intermetalloid with CsCl type lattice with a parameter of approximately 3.0. The results of this experiment indicate that hardening of the Fe-Ni-Ti alloy during heating is associated with the initial stages of formation of an ordered  $\text{NiTi}$  phase. Orig. art. has: 6 figures and 1 table.

ASSOCIATION: Institut metallovadeniya i fiziki metallov, TSNIICHERMET, imeni I. P. Bardina (Institute of Metal Studies and Physics of Metals)

Card 3/4

*PERKAS, M.D.*  
GOLUBKOV, V.M.; IL'INA, V.A.; KRITSKAYA, V.K., kand.fiz.-mat.nauk; KURDYUMOV, G.V.,  
akademik; PERKAS, M.D., kand.tekhn.nauk

Studying physical factors determining alloyed iron hardening. Probl.  
metalloved. i fiz. met. no.5:433-461 '58. (MIRA 11:4)  
(Iron alloys--Hardening)

SOV/126--7-5-18/25

AUTHORS: Kurdyumov, G. V., Perkas, M. D., and Khandros, L. G.

TITLE: On the Role Played by Secondary Distortions in the Hardening of Metals (O roli iskazheniy vtorogo roda v uprochnenii metallov)

PERIODICAL: Fizika metallov i metallovedeniye, Vol 7, Nr 5, pp 747-751 (USSR)

ABSTRACT: In this paper binary Fe-Ni alloys containing 10, 25 and 28% nickel were investigated. The specimens were quenched from 1000 - 1050°C and subsequently tempered in the temperature range 100-550°C for 1 hour. The alloy containing 25% Ni was particularly thoroughly investigated. Hardening by quenching results in considerable secondary distortions ( $\Delta a/a = 2.8 \times 10^{-4}$ ), the magnitude of which is close to that obtained in quenched steel containing 0.1% carbon (see Ref.9). The mosaic blocks are broken up to a size of  $3 \times 10^{-6}$  cm, and the ultimate tensile stress ( $\sigma_s$ ) and hardness ( $H_V$ ) are 80 kg/mm<sup>2</sup> and 265 VPN, respectively. Subsequent tempering at 300°C brings about a decrease in the secondary distortion (from  $2.8 \times 10^{-3}$  to  $1.9 \times 10^{-3}$ ), but the remaining properties  $D$ ,  $H_V$ ,  $\sigma_s$  remain practically unaltered (see Fig.1).

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SOV/126. --7-5-18/25

On the Role Played by Secondary Distortions in the Hardening of Metals.

Heating the specimens to higher temperatures leads to a further decrease in secondary distortions, and after tempering at 450°C  $\Delta a/a$  is  $0.3 \times 10^{-3}$ . After such tempering the hardness and UTS remain practically unaltered, but the block size tends to increase. On heating the specimens to above 460°C the reverse transformation  $\alpha \rightarrow \gamma$  takes place, and therefore after cooling to room temperature the microstructure contains the  $\gamma$ -phase together with the  $\alpha$ -phase. This  $\gamma$ -phase possesses an increased resistance to transformation to martensite on subsequent cooling. In this connection a study of specimens of this alloy, tempered at temperatures above 460°C, was inexpedient. An attempt was made to attain at least some softening of the Fe + 25% Ni alloy by lengthy soaking of the specimens at a temperature somewhat lower than the beginning of the  $\alpha \rightarrow \gamma$  transformation. The specimen was tempered at 440°C for 70 hours. The experimental results, however, have shown that the hardness and the widths of interference lines were close to those obtained after 1 hour's tempering at 450°C. In the Fe + 10% Ni alloy the reverse  $\alpha \rightarrow \gamma$  transformation begins at approxi-

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30V/126-5-18/25

On the Role Played by Secondary Distortions in the Hardening of Metals

mately 600°C. Therefore the quenched specimens can be tempered at least up to 550-580°C without running the risk of  $\chi$ -phase formation. Data on the change of the fine structure and hardness of this alloy are shown in Fig.2. The extent of secondary distortions in a 10% Ni alloy changes little after tempering at 300°C, but a considerable decrease in secondary distortions occurs in a temperature range above 300°C. On tempering at above 450°C an increase in block size and some decrease in hardness is observed. For an Fe + 28% Ni alloy the nature of the change in hardness and fine structure on tempering was the same as in the case of the 25% Ni alloy. In order to elucidate the role played by secondary distortions in the hardening of alloyed iron the following experiments were also carried out with a quenched specimen of the 25% nickel alloy. The alloy hardened by quenching exhibited the following values:  $\Delta a/a = 2.8 \times 10^{-3}$ ,  $D = 2.8 \times 10^{-6}$  cm and  $H_V = 260$  (see Fig.1). After tempering at 400°C for 1 hour the hardness and block size were practically unaltered and the secondary distortions had decreased to  $0.7 \times 10^{-3}$  (Fig.1). The specimen was then given a cold plastic deformation with a summary reduction in area of 50%. After deformation the secondary distortions had again increased from  $0.7 \times 10^{-3}$

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SOV/126- --7-5-18/25

## On the Role Played by Secondary Distortions in the Hardening of Metals

to  $2.0 \times 10^{-3}$ . The block size and hardness were  $2.9 \times 10^{-6}$  cm and 270  $H_v$  respectively; i.e. they had remained at the same level (see Table p.750). The other specimens of the same alloy were tempered at  $450^\circ\text{C}$  after quenching. After tempering,  $\Delta a/a$  was  $0.3 \times 10^{-3}$ ,  $D = 3.5 \times 10^{-3}$  and  $H_v = 265$ . As a result of a subsequent cold plastic deformation with a summary reduction in area of 60% the secondary distortions had increased to  $2.9 \times 10^{-3}$  whilst block size and hardness had again changed comparatively little ( $D = 2.8 \times 10^{-6}$  cm and  $H_v = 285$ ). Thus the available data on the relationship between hardness and fine crystal structure of metals and solid solutions enables one to conclude that the most important crystal structure factors determining the hardness of metals and one-phase alloys are, breaking down of the grain size to fragments of  $10^{-3}$ - $10^{-4}$  cm with a considerable disorientation of the lattice between the fragments, and the formation, within the fragment, of a sub-microscopic block structure.

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SOV/126. --7-5-18/25  
On the Role Played by Secondary Distortions in the Hardening of Metals

There are 2 figures, 1 table and 9 Soviet references.

ASSOCIATION: Institut metallovedeniya i fiziki metallov TsNIICbM,  
Institut metallofiziki AN USSR (Institute of Metallurgy and  
Physics of Metals TsNIICbM, Institute of Metal Physics,  
Ac. Sc., Ukrainian SSR)

SUBMITTED: January 22, 1959

Card 5/5

SOV/126---7-5-19/82

AUTHORS: Kardonskiy, V. M., Kurdyumov, G.V. and Perkas, M. D.

TITLE: Influence of the Properties of Crystals on the Strength of Metals in the Hardened Condition (O vliyanií svoystv Kristallov na prochnost' metallov v uprochnennom sostoyanii)

PERIODICAL: Fizika metallov i metallovedeniye, Vol 7, Nr 5, pp 752-756 (USSR)

ABSTRACT: Kurdyumov et alii (Ref.2) have shown that there exists a linear relationship between the degree of secondary distortion and the hardness of martensite in quenched low C steels (see Fig.1). Golubkov et alii (Ref.3) have shown that there exists a direct relationship between the degree of secondary distortion and the hardness of alloyed iron after cold plastic deformation (see Fig.2). Using results obtained by the latter authors a diagram has been constructed (Fig.3) showing the dependence of the degree of secondary distortion, arising as a result of cold plastic deformation, on the hardness of the original annealed alloy iron. From the above diagram it can be seen that the absolute hardness of hardened alloys is determined not only by the fine grain structure but also by

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SOV/126- --7-5-19/25

Influence of the Properties of Crystals on the Strength of Metals in the Hardened Condition

the properties of the crystals of the original metals as annealed. These properties also determine the elastic limit of micro-regions,  $\Delta\sigma/\sigma$ , in the hardened state. For a further study of the above conclusions the authors investigated alloys in which the properties of solid solution crystals strongly depended on the concentration of the dissolved elements. Among the iron alloys the most suitable ones for investigation are iron-silicon alloys with a silicon content up to the limiting solid solubility in  $\alpha$ -iron. The chemical composition of the original iron and its alloys with silicon is given in Table 1. The methods used for the study were the same as those employed by Golubkov et alii (Ref.3). In Table 2 the results of hardness, UTS and temporary resistance measurements of annealed alloys are shown. In Fig.3 curves are plotted which express the dependence of hardness on the degree of plastic deformation. The relationship between the strength properties and the fine structure in the hardened state were studied in specimens of alloys which had been deformed at identical loads (85 tons). The degree of deformation was found to vary from 68% for iron free from silicon to 48%

Card  
2/4

SOV/126--7-5-19/25

## Influence of the Properties of Crystals on the Strength of Metals in the Hardened Condition

for an alloy containing 9.4% Si. In accordance with the results shown in Fig.4 the hardening of all the alloys must be close to "saturation". The results of the study of the specimens are shown in Fig.5. These show that the increase in hardness as a result of cold deformation is not related to the magnitude of secondary distortions arising during deformation as it is practically independent of the Si concentration, whilst  $\Delta\sigma/\sigma$  increases by nearly twice.

However,  $\Delta\sigma/\sigma$  increases proportionately to the hardness of the annealed material. Thus the results obtained are in agreement with the idea that the secondary distortions are not alone responsible for the hardness arising from the cold deformation and martensite transformation, but reflect the properties of crystals of a given material, characterizing the "limit" of the elastic deformation of micro-regions. These properties determine the level of the strength which can be attained as a result of changes in the internal microscopic and sub-microscopic grain structure in the hardening process.

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SOV/126- --7-5-19/25  
Influence of the Properties of Crystals on the Strength of Metals in  
the Hardened Condition

There are 5 figures, 2 tables and 7 references, of which 6  
are Soviet and 1 English.

ASSOCIATION: Institut metallovedeniya i fiziki metallov TsNIICM  
(Institute of Metallurgy and Metal Physics TsNIICM)

SUBMITTED: January 22, 1959

Card 4/4

PERKAS, M.D., kand.tekhn.nauk

Determining the depth of decarburization and the cementation  
layer by means of the X-ray method. Probl.metalloved.i fiz.met.  
no.6:363-371 '59. (MIRA 12:8)  
(Cementation (Metallurgy)--Testing) (Steel--Testing)  
(X-ray crystallography)

L 22992-66 EWT(m)/EWA(d)/T/EWP(t) LJF(c) ID/HW

ACC NR: AP6012231

SOURCE CODE: UR/0129/66/000/004/0007/0010

AUTHOR: Kardonskiy, V. M.; Perlas, M. D.

ORG: TSNIICHERMET

TITLE: Aging of the Fe-Ni-Mn steel martensite

SOURCE: Metallovedeniye i termicheskaya obrabotka metallov, no. 4, 1966, 7-10

TOPIC TAGS: alloy steel, maraging steel, nickel containing steel, manganese containing steel, steel aging, steel property, steel structure

ABSTRACT: The effect of aging on the structure and properties of steel containing 6% Ni + 5% Mn, 8% Ni + 4% Mn, 13% Ni + 2% Mn, 16% Ni, or 8% Mn has been investigated. The effect of aging was found to depend on aging temperature and nickel and manganese content. Steel with 16% Ni aged at 350—500C softened. Partial substitution of nickel by manganese increased hardness; the higher manganese content the greater the increase. The maximum hardness increase (-HV490 was observed in steel with 6% Ni and 5% Mn (see Fig. 1). The presence of nickel is essential for effective increase of steel hardness at aging. In steel containing 16% Ni and 2% Mn, the yield strength increased to 100 kg/mm<sup>2</sup> and the tensile strength to 110 kg/mm<sup>2</sup> after aging at 350—450C, both dropped to 52 and 90 kg/mm<sup>2</sup> after aging at 600C. Elongation, reduction of area, and notch toughness are affected only slightly by aging at 400—600C. In as-hardened steel containing 8% Ni and 4% Mn, the structure consists of martensite crystals with

Cord 1/3

UDC: 621/785.789:669.15-194:669.24'74

L 22992-66

ACC NR: AP6012231

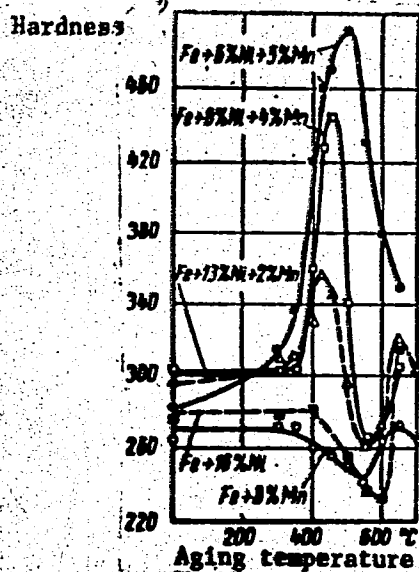


Fig. 1. Hardness versus aging temperature for Ni-Mn steels

a high dislocation density; it changes little with aging at temperatures up to 400C. Segregations 40—50 Å in size were observed in specimens aged at 450C, at which temperature the maximum strengthening of steel was reached. Aging at 510C increased the

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L 22992-66

ACC NR: AP6012231

particle size of the  $\gamma$ -phase and reduced hardness; aging at 550C decreased the dislocation density in the  $\alpha$ - phase. The size of particles of the  $\gamma$ -phase and the intervals between them increased, and the steel had a minimum strength. The reverse transformation from  $\gamma$  to  $\alpha$  occurred at temperatures over 550C. Orig. art. has: 3 figures. [AZ]

SUB CODE: 11, 13/ SUBM DATE: none/ ORIG REF: 005/ OTH REF: 004/ ATD PRESS: 4238

Cord

3/3

PERKAS, M.D.

Increasing the hardness of martensite in iron-nickel base alloys during heating. Probl. metalloved. i fiz. met. no.8:28-43 '64. (MIRA 18:7)

L 51990-65 EPF(n)-2/EWP(z)/EWA(c)/EWT(m)/T/EWP(b)/EWP(t) Pu-4/Pad  
 IJP(c) WW/JD/HW/JG  
 ACCESSION NR: AT5011201

UR/2717/64/000/008/0028/0043  
 32/  
 33/  
 34/

AUTHOR: Perkas, M. D.

TITLE: Increasing the strength of martensite in alloys based on the  
iron-nickel system by heating

SOURCE: Dnepropetrovsk. Institut metallovedeniya i fiziki metallov.  
 Problemy metallovedeniya i fiziki metallov, no. 8, 1964, 28-43

TOPIC TAGS: martensite, martensitic transformation, metal hardness,  
 metal hardening, metal heating, metal structure, metal ductility,  
 strengthening, alpha phase, gamma phase, temperature dependence,  
 activation energy, tempering, modulus of elasticity, coercivity,  
 electric resistance, iron base alloy, nickel containing alloy,  
 titanium containing alloy, manganese containing alloy, aluminum  
 containing alloy, columbium containing alloy, zirconium containing  
 alloy, molybdenum containing alloy

ABSTRACT: The object of the work was to obtain material with a  
 strength more than 220-230 kg/mm<sup>2</sup> by heat treatment alone. The first  
 subject investigated was strengthening as a result of direct and

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L 51990-65

ACCESSION NR: AT5011201

4% manganese, and 0.8% titanium, the activation energy is 34,000 cal/g-atom, and for 8% nickel, 0.8% aluminum, and 1% titanium it is 21,000 cal/g-atom. The fifth subject investigated was the effect of initial structure on martensite hardening during heating. Increase in the number of defects in the alpha phase leads to an increase in hardness. The sixth subject was strength and ductility after low temperature tempering. Samples treated under optimum conditions (tempering at 425°C, 1 hrs) in which hardness rose from 260 to 530 HV had strengths less than before tempering (less than 100 kg/mm<sup>2</sup>). The modulus of elasticity reaches a maximum at 600°C. The seventh subject was coercivity and electrical resistance. In the temperature region in which hardness increases, electric resistance increases and coercivity decreases. In the region of temperatures where the alpha to gamma transformation occurs, coercivity rises and electric resistance decreases. Orig. art. has: 21 figures.

ASSOCIATION: Institut metallovedeniya i fiziki metallov, Dnepropetrovsk  
(Institute of Physical Metallurgy and Physics of Metals)

SUBMITTED: 00

ENCL: 00

SUB CODE: MM

NR REF SOV: 010

OTHER: 005

Card 3/3

L 51990-65

ACCESSION NR: AT5011201

reverse alpha to and from gamma transformations. Samples of iron-nickel alloys were quenched in water from 1,000°C. Greatest increase in hardness of the alpha phase was in the alloy containing 16.5% nickel (samples had 6-25% nickel). After quenching, the samples had a hardness of 265 HV. Heating the samples to 600-625°C for one hour increased the hardness of the martensite to 315-320 HV. The effect of increased hardness of the alpha phase as a result of the preliminary alpha to gamma transformation is greater the lower the temperature of the start of the transformation. The second subject investigated was hardening of martensite by heating. Increased hardness of martensite in alloys with titanium and in iron-nickel-manganese alloys after low temperature heating (300-450°C) is not accompanied by any change in the fine structure and is due to other processes taking place in the alpha phase. The third subject investigated was the effect of alloying elements on hardening of martensite during heating. Hardening of martensite with heating in the interval 350-500°C is observed in iron-nickel alloys alloyed with titanium, aluminum, manganese, columbium, zirconium, and molybdenum. The fourth subject investigated was the kinetics of change in martensite hardness during heating. For alloys containing 8% nickel,

Card 2/3

PERKAS, M.D.

Mechanical properties of alloys with aging martensite. Metalloved. i  
term. obr. met. no.11:5-10 N '64. (MIRA 18:4)

1. Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metal-  
lurgii imeni I.P.Bardina.

KARDONSKIY, V.M.; PERKAS, M.D.

Electron microscopy of the aging of the Fe-Ni-Al alloy. Metalloved.  
1 term. obr. met. m.11:15-19 N '64. (MIRA 18:4)

1. Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metal-  
lurgii imeni I.P.Bardina.

L 53732-65 EWI(m)/ENP(w)/EWA(d)/EFR/T/ENP(t)/ENP(k)/ENP(z)/ENP(b)/EWA(c) Pf-4/  
 PaB/PS-4 IJP(c) JD/HM

ACCESSION NR: AP5011757

UR/0126/65/019/004/0631/0633  
 539.25

AUTHOR: Perkas, M. D.; Potapov, L. P.

TITLE: Variation in the physical properties of martensite during aging

SOURCE: Fizika metallov i metallovedeniye v. 19, no. 4, 1965, 631-633

TOPIC TAGS: martensite, metal physical property, aging, maraging alloy

ABSTRACT: Aging was studied in Fe-Ni martensites containing Ti or Al. Two alloys, Fe + 8% Ni + 1.5% Ti and Fe + 8% Ni + 1.5% Al, were quenched from 900°C, and then aged in the 350-600°C temperature range. This aging process increases the strength and changes such physical properties as the modulus of elasticity ( $E$ ), electrical resistance ( $\rho$ ), Vicker's hardness ( $HV$ ), coefficient of thermal expansion ( $\alpha$ ), and characteristic "x-ray" temperature ( $\theta$ ). The curves for  $\alpha$ ,  $\Delta E/E$ , and  $HV$  as functions of aging temperature all show maxima. Those for  $\rho$  and  $G$  show minima. The maxima and minima mentioned do not always coincide with the same aging temperature, but fall within a range of temperatures from 500 to 600°C. The results are explained by redistribution of the atoms in the solid solution with martensite and/or the

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L 53732-65

ACCESSION NR: AP5011757

appearance of a new phase, possessing a high modulus of elasticity. Electron microscope analysis of thin foils of the Fe-Ni-Ti alloy after aging confirmed the presence of a NiTi phase, having an ordered structure similar to CsCl. The change in physical properties is thus associated with the beginning of segregation of a new phase. There are no changes in physical properties when Fe+8% Ni is heated in the 200-700°C range. Orig. art. has: 3 figures.

ASSOCIATION: Institut metallovedeniya i fiziki metallov TsNIICHERMET im. I. P. Bardina (Institute of Metal Science and the Physics of Metals, TsNIICHERMET)

SUBMITTED: 27Jul64

ENCL: 00

SUB CODE: MM

NO REF SOV: 004

OTHER: 000

Card 2/2

1 35016-55 EWP(a)/EWT(m)/EWP(w)/EWA(d)/T/EWP(t)/EWP(b)/EWA(b) IJP(c) MJW/  
 JD/IM  
 ACCESSION NR: AP5007005 6/0129/65/000/003/0037/0040  
 AUTHOR: Kardonskiy, V. M. Perkas, M. D.  
 TITLE: Cause of the embrittlement of ferritic-austenitic stainless steel  
 SOURCE: Metallovedeniye i termicheskaya obrabotka metallov, no. 3, 1965, 37-40,  
 and insert facing p. 41  
 TOPIC TAGS: stainless steel, ferritic austenitic stainless steel, steel embrittle-  
 ment/1Kh21N5T steel, OKh21N5T  
 ABSTRACT: Several ferritic-austenitic stainless steels containing 0.03-0.11% C,  
 21.08-22.10% Cr, 5.15-5.30% Ni, 0-0.98% Ti, and 0-1.53% Al have been studied  
 to determine the cause of the embrittlement which develops in 1Kh21N5T(EI811) and  
 OKh21N5T(EI811) steels at 400-550C. Experiments showed that in steels containing  
 secondary phases) at

lation along grain

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ACCESSION NR: AP5007005

phase formed in the process of aging has a cubic structure, most probably of the CsCl type, and the same crystal lattice as the matrix with a parameter twice as large as that of the matrix (5.73 Å). It is expected that alloying with boron would promote a more regular distribution of the precipitated particles and reduce the embrittlement. Orig. art. has: 3 figures and 1 table. [ND]

ASSOCIATION: TERNICHERMET

SUBMITTED: 00

ENCL: 00

SUB CODE: MM

NO REF SOV: 003

OTHER: 001

ATD PRESS 3216

Card 2/2

L 20108-65 EWT(m)/EWP(w)/EWA(d)/EWP(t)/T/EWP(b) Pad IJP(c)/ASD(m)-3 JD/JW/HW  
 S/0129/64/000/011/0005/0010  
 ACCESSION NR: AP4049103

AUTHOR: Perkas, M. D.

TITLE: Mechanical properties of alloys with aged martensite

SOURCE: Metallovedeniye i termicheskaya obrabotka metallov, no. 11, 1964, 5-10

TOPIC TAGS: nickel steel, martensitic steel, martensite mechanical property, aged martensite, martensite stability, austenite stability

ABSTRACT: Experiments run on tempered nickel-iron martensitic alloys heated to 350-600C showed that 11-12% Ni, 2.35% Ti, and 1.38% Al were the amounts producing optimal hardness at about 500C. The kinetics of the change in hardness during aging were studied with quenched alloy samples containing 8% Ni, 0.9% Al, and 1% Ti, and with samples put through quenching and subsequent cold deformation of 80% to establish norms at 450C. Other alloys containing 8-17%, 0.8-1.5% Ti, 0-1% Al, 0-5.2% Mo, and 0-4.3% Co were tested for the effect of aging on the stability of austenite (500C) and martensite (200C). Results showed that there was no significant effect on austenite, but martensite stability was increased considerably while preserving satisfactory resiliency. X-ray analyses of nickel-iron alloys containing titanium and aluminum at temperatures which increase the durability of martensite show a marked decrease in interference. Lack of significant

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L 20108-65  
ACCESSION NR: AP4049103

decrease in the size of martensite nodes, the magnitude of the energy of activation of the process ( $U = 2.5-4 \times 10^4$  cal/g atom), and the clear time dependency of the process shows that the decrease in x-ray interference is due to the diffusion of the atoms of alloying elements. Aging martensitic alloys is a satisfactory method in all respects for improving durability while retaining resilience. Orig. art, has: 8 graphs and 1 table.

ASSOCIATION: TsNICherMET

SUBMITTED: 00

ENCL: 00

SUB CODE: MM

NO REF SOV: 002

OTHER: 003

Card 2/2

L 20107-65 EPA(s)-2/EWT(m)/EPR/T/EWP(t)/EPA(bb)-2/EWP(b) Pad/PS-4/Pt-10  
IJP(c)/SSD/ATWL/JSD(m)-3 JD/HW  
8/0129/64/000/011/0015/0019

ACCESSION NR: AP4049105

AUTHOR: Kardonskiy, V. M.; Perkas, M. D.

TITLE: Electron microscopic study of the aging of Fe-Ni-Al alloys

SOURCE: Metallovedeniye i termicheskaya obrabotka metallov, no. 11, 1964, 15-19

TOPIC TAGS: nickel steel, aluminum containing alloy, martensitic steel, martensite aging, electron microscopy, martensite microstructure

ABSTRACT: The effects of heat in increasing martensite durability are well known, but the nature of the process is not. Direct electron microscopic examination was therefore performed with a UEMV-100 scope having an accelerating voltage of 100 kv on Fe-Ni-Al alloys containing 8.2% Ni and 1.6% Al during aging at 680-700C for periods of 1-5 hours. At this temperature, the  $\alpha$ - $\gamma$  transformation does not occur. X-ray analysis for the characteristic interference patterns of martensitic formations was also performed. The samples were quenched from 900C, and the  $\gamma$ - $\alpha$  transformation proceeded either by normal or martensitic means, depending on the use of rapid or slow quenching processes. Pictures were taken at all points on all experimental and control samples. Aging with the separation of (Ni, Fe) Al and Ni<sub>3</sub>Al proceeds in both  $\alpha$ -phase with martensitic structure and in ferrite with a nearly equilibrium structure. The composition of the original  $\alpha$ -phase

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1 20107-65  
ACCESSION NR: AP4049105

may affect durability after aging. Aging temperatures must be above 500C for the (Ni, Fe) Al aggregates to be large and numerous enough to be observed. Above 500C, separation of Ni<sub>3</sub>Al is also increased, but without any noticeable effect on the durability of the  $\alpha$ -phase after aging. The increase in durability is connected with the initial stage of formation of areas with the (Ni, Fe)Al structure, cohering to the matrix, and, in fact, this seems responsible for the significant hardening during aging. Orig. art. has: 5 photomicrographs.

ASSOCIATION: TsNIChermet

SUBMITTED 00

ENCL: 00

SUB CODE: MM

NO REF SOV: 005

OTHER: 004

Card 2/2

KARDONSKIY, V.M.; KURDYUMOV, G.V.; PERKAS, M.D.

Effect of size and shape of cementite particles on the structure  
and properties of steel following deformation. Metalloved. i  
term. obr. met. no.2:2-8 F'64 (MIRA 17:7)

1. Tsentral'nyy nauchno-issledovatel'skiy institut chernoy  
metallurgii imeni Bardina.

KURDYUMOV, G.V.; PERKAS, M.D.

Metal hardening and recovery. Issl. po zharopr. splav. 9:3-14  
'62. (MIRA 16:6)  
(Metals--Hardening) (Crystal lattices)

PERKAS, M.D.

Investigating the structure and properties of the alpha-phase of alloys on a base of the system iron - nickel. Fiz.met.1 metalloved. 15 no.4:554-564 Ap '63. (MIRA 16:6)

1. Institut metallovedeniya i fiziki metallov TSentral'nogo nauchno-issledovatel'skogo institut chernoy metallurgii.  
(Iron-nickel alloys--Metallography)  
(Phase rule and equilibrium)

L-11084-63

SWP(q)/EWI(m)/BDS--AFFIC/ASD--JD

ACCESSION NR: AP3000098

8/0126/63/015/004/0554/0364

53  
52

AUTHOR: Perkas, M. D.

TITLE: Investigation of the structure and properties of the Alpha phase of iron-nickel-base alloys (d)

SOURCE: Fizika metallov i metallovedeniye, v. 15, no. 4, 1963, 554-564

TOPIC TAGS: iron-nickel alloy, iron-nickel-titanium alloy, iron-nickel-manganese alloy, iron-nickel-titanium maraging alloy, reversed maraging alloy, reversed martensitic transformation, Alpha-phase strengthening, Gamma-phase strengthening, cobalt addition, molybdenum addition

ABSTRACT: To determine the feasibility of obtaining materials with a strength above 220-230 kg/mm<sup>2</sup> exclusively by heat treatment (without plastic deformation), the effect of reversed  $\alpha$  to  $\gamma$  transformation in a series of Fe-Ni base alloys has been investigated. Six straight Fe-Ni alloys containing 6.0-25.0% Ni were annealed at 1000C, water quenched, and tempered at temperatures up to 750C. A rather substantial increase in hardness was observed only in the Fe-16.5% Ni whose

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L 11084-63

ACCESSION NR: AP3000098

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as-quenched hardness of 365 HV increased to 315–320 HV after tempering for one hour at 600–625C. In general, however, the strengthening effect of  $\gamma$ -to- $\alpha$ -to- $\gamma$  transformations in straight Fe-Ni alloys was insignificant. Much greater strength was produced by alloying Fe-Ni alloys with 0.8% Ti; 1-hr tempering at 425C increased the hardness of this alloy from about 225 to 365 HV. A still greater increase from about 250 to 425 HV, was observed in the Fe-8% Ni-4% Mn-0.8% Ti alloy. In both cases, however, the strengthening was found to be associated neither with the  $\alpha$ -to- $\gamma$  transformation, which occurred above 500C in the Fe-8% Ni-4% Mn-0.8% Ti alloy, nor with substructural changes such as changes in block size or in the magnitude of second-type distortions. Cold reduction slightly lowered the temperature at which the hardness of Fe-0.8% Ni-4.0% Mn-0.8% Ti alloy began to increase, and subsequent tempering for 1-hr at 425C increased the hardness of the alloy to 530 HV. The increase in hardness, however, was accompanied by a sharp decrease in ductility; when tempered for 3 hr at 425C, the alloy became so brittle its tensile strength dropped below the strength of the as-quenched alloy, while its compression strength rose to 220–230 kg/mm<sup>2</sup>. Ductility was significantly improved by additional alloying with Co or Mo. Such alloys tempered at 425–450C for 3 hr had a tensile strength of 250–260 kg/mm<sup>2</sup>, a reduction of area of 18–30%, and an elongation of 3–5%. Orig. art. has: 12 figures.

Association: Inst. of Metal Science and the Physics of Metals.

Card 2/62

KARDONSKIY, V.M.; KURDYUMOV, G.V.; PERKAS, M.D.

Fine crystal structure of cold-deformed, high-carbon steel.

Fiz. met. i metalloved. 15 no.2:244-253 F '63.

(MIRA 16:4)

1. Institut metallofiziki Tsentral'nogo nauchno-issledovatel'-  
skogo instituta chernoy metallurgii.

(Steel—Metallography)

(Crystal lattices)

S/124/63/000/002/041/052  
D234/D308

**AUTHORS:** Kardonskiy, V.M., Kurdyumov, G.V. and Perkas, M.D.

**TITLE:** The connection between the variation in fine structure and resistance to plastic deformation in metals and alloys after strengthening

**PERIODICAL:** Referativnyy zhurnal, Mekhanika, no. 2, 1963, 61, abstract 2V510 (Sb. tr. In-t metalloved. i fiz. metallov. Tsentr. n.-i. in-ta chernoy metallurgii, 1962, v. 7, 7-23)

**TEXT:** From the results of X-ray investigations on strengthening of metals and alloys it is concluded that, in order to increase the strength and to make it approach the theoretical, it is necessary to form states with the largest possible dispersity of grain structure.

[Abstracter's note: Complete translation]

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S/126/63/015/002/014/033  
E193/E383

AUTHORS: Kardenskiy, V.M., Kurdyumov, G.V. and Perkas, M.D.

TITLE: The fine structure of cold-worked high-carbon steel

PERIODICAL: Fizika metallov i metallovedeniye, v. 15, no. 2, 1963,  
244 - 253

TEXT: The object of the present investigation was to study the relationship between the strength and fine structure of steel subjected to heat and mechanical treatment and to explain the part played by cementite and by its particle size in the formation of fine structure in the deformed  $\alpha$ -phase. The experiments consisted of the following. Hot-rolled, 1.5 - 2.0 mm thick strip of steel  $\gamma_{10}$  (U10) and  $\gamma_{12}$  (U12) was (1) continuously patented by passing (at 2.7 m/min) through a furnace at  $920^{\circ}\text{C}$  and then through a lead bath at  $420^{\circ}\text{C}$ , or (2) annealed by maintaining for 20 min at  $880^{\circ}\text{C}$ , furnace-cooling to  $600^{\circ}\text{C}$  and then cooling in air to room temperature. The heat-treated strip was then cold-rolled to up to 93% reduction thickness. The UTS attained in steels U10 and U12 after patenting and cold-rolling was 270-290 and 300-320 kg/mm<sup>2</sup>, respectively, the UTS of annealed and cold-rolled steel U10 being 180 kg/mm<sup>2</sup>. The

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The fine structure ....

S/126/63/015/002/014/033  
E193/E383

fine structure of steel after various degrees of cold deformation was studied with the aid of an electron microscope, X-ray diffraction measurements being used to determine the block dimensions and the magnitude of distortions of the second type. Conclusions:

1) the formation of sub-structure in ferrite during plastic deformation depends to a great extent on the presence of cementite and on the shape and size of crystals of this constituent. Small (0.1-0.2  $\mu$ ) spacing between the platelets of the eutectoid, ensured by the patenting treatment, creates conditions favourable for a considerable reduction in the block dimensions of ferrite (100 - 150  $\text{\AA}$ ) and cementite (30-50  $\text{\AA}$ ) in cold-deformed steel. This is demonstrated in Fig. 10, where the UTS ( $\sigma_B$ , kg/mm<sup>2</sup>), block dimensions ( $D \cdot 10^6$  cm) and the magnitude of distortions of the second type ( $\Delta a/a$ ) of steel U12 are plotted against the degree of deformation (bottom scale, %) and thickness of the strip (upper scale, mm), the circles and dots representing, respectively, the results obtained for patented and annealed specimens. 2) The high degree of fragmentation of the ferrite and cementite, high degree of misalignment of blocks in the interior of the grains, formation

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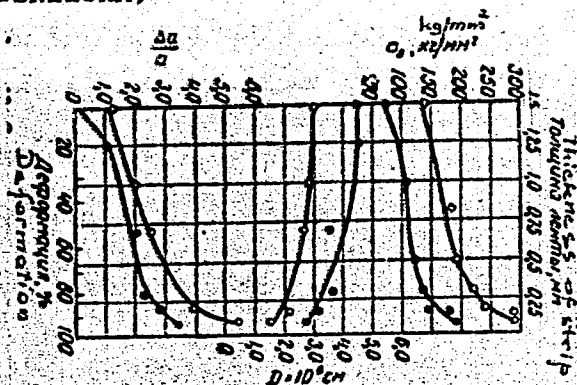
S/126/65/015/002/014/035  
E193/E583

The fine structure .....

of a very dense network of obstacles to movement of dislocations (both present in the ferrite grains and in the form of grain boundaries between ferrite and cementite particles) constitute the main causes of high strength of patented and cold-worked steel strip. There are 11 figures and 1 table.

ASSOCIATION: Institut metallofiziki TsNIICHM (Institute of Metal Physics, TsNIICHM)

SUBMITTED: August 1, 1962



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Fig. 10

S/137/62/000/012/023/085  
A006/A101

AUTHORS: Kardonskiy, V. M., Kurdyumov, G. V., Perkas, M. D.

TITLE: The relation between changes in the fine structure and plastic deformation resistance of metals and alloys after strengthening

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 12, 1962, 43, abstract 121258 ("Sb. tr. In-t metalloved. i fiz. metallov Tsentr. n.-1. in-ta chernoy metallurgii", 1962, v. 7, 7 - 33)

TEXT: The following two means of increasing the strength are indicated:  
1) the formation of a fine micro- or submicro-heterogeneous grain structure with the aid of thermal or mechanical treatment, i.e. the production of a maximum amount of lattice defects; 2) the production of crystals without defects. The first method of increasing the strength is analyzed. A description is given of known methods for treating metals and alloys which make it possible to obtain a submicro-heterogeneous structure (thermal and mechanical treatment, their combination, neutron effect, electron effect etc.). The plastic deformation resistance can also be risen by alloying. However, none of the indicated methods

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A006/A101

The relation between changes in the...

yields a strength exceeding one quarter of the theoretical value. Two directions should be distinguished when investigating the problem of strength: the revealing of the relation between the purely structural changes in the crystal structure and the increase in strength, and studying the factors which predetermine the different strength level of metals and alloys after strengthening. The authors describe the basic results of experimental investigations, carried out at the Institute of Metal Science and Metal Physics at TsNIICM. Information is given on the part of individual elements of fine structure in the strengthening of metals. The investigations were conducted with Fe and its alloys. The basic crystallostructural factor, predetermining the strengthening effect, is the submicro-heterogeneity; the crystal grains consist then of fragments of domains of  $10^{-3}$  -  $10^{-4}$  cm size with considerable disorientation; the latter consist of domains of  $10^{-5}$  -  $10^{-6}$  cm size. During the deformation process, the maximum intensity of strengthening coincides with the sharpest reduction in size of the coherent scattering zones. The temperature range where the zones of coherent scattering grow, coincides with the softening range. The crushing of fragments and refining of coherent zones during the deformation process are inseparably connected with an increasing degree of their disorientation. After

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A006/A101

considerable deformations the angle of maximum disorientation attains  $10^{\circ}$  -  $15^{\circ}$ ;  
the angle between adjacent fragments is  $40'$  -  $50'$  and between the domains  $1'$  -  $2'$ .  
There are 37 references.

V. Geminov

[Abstracter's note: Complete translation]

Card 3/3

KARDONSKIY, V.M.; KURDYUMOV, G.V., akademik; PERKAS, M.D., kand.tekhn.nauk

Connection between changes in the fine crystal structure and  
the resistance to plastic deformation in metals and alloys after  
hardening. Probl.metalloved.i fiz.mot. no.7:7-33 '62. (MIRA 15:5)

(Metallography) (Deformations (Mechanics))

40971

S/659/62/009/000/001/030  
1003/1203

AUTHORS Kurdyumov, G V and Perkas, M D  
TITLE On strengthening and softening of metals  
SOURCE Akademiya nauk SSSR. Institut metallurgii. Issledovaniya po zharoprochnym splavam.  
v. 9. 1962. Materialy Nauchnoy sessii po zharoprochnym splavam (1961 g.), 3-14

TEXT The resistance of metals and alloys to deformation is influenced by two factors: 1) the dimensions of the blocks of the mosaic structure and 2) properties of the crystal which determines its resistance to dislocation movements. This influence is additive. Discussion:- I. Ya. Dekhtyar expressed the opinion that there must also be short and long-range orders in the metals, and proposed checking the relationship between the properties investigated by the authors and the order of the crystal lattices of the metals. I. A. Odintsov stated that superstrength metals with no dislocations can be produced, and stressed the difficulties which may arise if the problem of increasing the elasticity modulus of these metals remain unsolved. A V Stepanov suggested that the possibility of producing superstrength materials should be investigated by producing new modifications of such non-metals as sulfur using high temperatures and pressures, like the carbon modification of diamond. He claims that this hypothetical sulfur modification would have a melting point of 35000°K, and better mechanical properties than diamond. According to I. A. Gindin, the most effective method for obtaining a fine mosaic structure and thus increasing the creep resistance for pure metals is cold-working at low temperatures (77-4°K). There are 8 figures

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S/123/62/000/011/006/011  
A052/A101

AUTHOR: Perkas, M. D.

TITLE: X-ray determination of thickness of decarbonized and case hardened layer

PERIODICAL: Referativnyy zhurnal, Mashinostroyeniye, no. 11, 1962, 38, abstract 11B225 ("Sb. tr. In-t metallov Tsentr. n.-1. in-ta chernoy metallurgii", no. 6, 1959, 363 - 371).

TEXT: The advantages and disadvantages of metallographic and chemical methods of determining the layer thickness are discussed. The X-ray method of determining the layer thickness is dealt with in detail; this method is based on the fact that the degree of tetragonality of the crystalline lattice of the martensite formed in the investigated layer of material depends on its carbon content. The higher the carbon content in the solid solution the greater the tetragonality and the doublet distance between the lines on the radiogram. The method is applicable at a carbon content not under 0.6%. However, the X-ray method can determine only that amount of carbon which is contained in the solid solution, in

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A052/A101

X-ray determination of...

other words, the carbon bound into carbides cannot be determined. The method of determining the depth of decarbonized layer consists in keeping 6 x 10 x 15 mm samples during 3 - 5 min in a salt bath at 1,000°C and hardening in 10% NaOH solution. Thereafter the material layers were etched off the sample with 10% HNO<sub>3</sub> solution, and the surface, after the next layer had been etched off, was radiographed with CK-3 (SK-3) camera. At 120 mm film-sample distance and radiography in chromium radiation the accuracy of the method is 0.05%. The method of determining the depth of case hardened layer consists in torch hardening 6 x 8 x 110 mm samples during 6 hours at 910°C. After 8 - 10 min cooling the samples were oil hardened and thus the initial state was fixed. Radiograms were taken in a camera with 573 mm drum diameter at chromium radiation. There are 8 figures.

Yu. Grinblat

[Abstracter's note: Complete translation]

Card 2/2

KURDYUMOV, G.V., akademik; PERKAS, M.D., kand.tekhn.nauk

Role of the properties of crystals and the substructure of the grain in metal strength. Metalloved. i term. obr. met. no.9: 33-43 S '61. (MIRA 14:9)

1. TSentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii. 2. Akademiya nauk SSSR (for Kurdyumov). (Metal crystals)

S/717/62/000/007/001/010  
D207/D301

AUTHORS: Kardonskiy, V.M., Kurdyumov, G.V., Member of the Academy of Sciences, USSR, and Perkas, M.D., Candidate of Technical Sciences

TITLE: Relationship between changes of the fine structure and the resistance to plastic deformation of metals and alloys after hardening

SOURCE: Dnepropetrovsk. Institut metallovedeniya i fiziki metallov. Problemy metallovedeniya i fiziki metallov, no. 7, Moscow, 1962, 7 - 33

TEXT: A review is given of the recent work on iron and its solid solutions carried out at the Institut metallovedeniya i fiziki metallov TsNIICHM (Institute of Metallography and Physics of Metals TsNIICHM). The fine structure is defined as microscopic and submicroscopic structural inhomogeneities in crystal grains. Such structure was investigated and related to changes in mechanical properties. The authors discuss work on cold plastic deformation, the effect of alloying, the

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... 1959.

KARDONSKIY, V.M.; KURDYUMOV, V.G.; KURDYUMOV, G.V.; PERKAS, M.D.

Effect of crystal properties and substructure on the metal strength.  
Part 1. Fe-Ni and Fe-Si alloys. Fiz. met. i metalloved. 11  
no. 4:609-614 Ap '61. (MIRA 14:5)

1. Institut metallovedeniya i fiziki metallov Tsentral'nogo  
nauchno-issledovatel'skogo instituta chernoy metallurgii.  
(Iron-nickel alloys—Metallography) (Iron-silicon alloys—Metallography)  
(Metals, Effect of temperature on)

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S/126/61/012/006/018/023  
E073/E535

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AUTHORS: Kardonskiy, V.M. and Perkas, M.D.

TITLE: On softening quenched and plastically deformed iron

PERIODICAL: Fizika metallov i metallovedeniye, v.12, no.6, 913-915

TEXT: For understanding the nature of hardening and softening it is important to study the features of the crystal structure of a material hardened by various methods, since the crystal structure of materials hardened by differing methods to the same resistance to plastic deformation may differ in some respects. In this paper the results are described of investigations on the binary alloys Fe + 2.2% Mn, Fe + 4% Ni and unalloyed iron. The hardening was effected by two methods: plastic deformation and quenching. Prior to quenching, the specimens were heated in a salt bath. The specimens of the unalloyed iron were quenched from 1150-1200°C in an aqueous solution of NaOH at 5°C, whilst the binary alloys Fe-Mn and Fe-Ni were water quenched from 1000°C. After quenching, the specimens of the unalloyed iron had a hardness of 180 HV, whilst the specimens of the Fe-Mn and Fe-Ni alloys had hardness values of 220 and 250 HV.

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respectively. The second series of specimens was work-hardened by rolling. Thereby, the degree of work-hardening was so chosen that the final hardness for each material was the same as for the respective quenched specimens. This was achieved by a total reduction of 50 to 60%. It was assumed that these two methods of hardening brought about changes in the crystal structure of each of the alloys, which led to an almost equal resistance to plastic deformation. After hardening and after various stages of softening, the hardness and the blurring of X-ray interference lines were determined. By means of metallographic and X-ray investigations the initial recrystallization temperature was determined. A difference was observed in the nature of the interference lines of the specimens which were hardened by quenching from those that were hardened by plastic deformation. The X-ray exposures of specimens that had been quenched showed characteristic reflections which were slightly extended along the arc of the Debye ring. In the case of the specimens hardened by plastic deformation a wide continuous line was observed or a line consisting of a band stretched along the entire arc of the

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KARDONSKIY, V.M.; KURDYUMOV, G.V.; PERKAS, M.D.

Effect of crystal properties and structure on the metal strength.  
Part 2: Iron and nickel. Fiz. met. i metalloved. 11 no. 4:615-  
619 Ap '61.

(MIRA 14:5)

1. Institut metallovedeniya i fiziki metallov Tsentral'nogo  
nauchno-issledovatel'skiy institut chernoy metallurgii.  
(Iron—Metallography) (Nickel—Metallography)  
(Metals, Effect of temperature on)

18-8200

26795  
S/129/61/000/009/005/006  
E193/E380

**AUTHORS:** Kurdyumov, G.V., Academician of the AS USSR and  
Perkas, M.D., Candidate of Technical Sciences

**TITLE:** On the Effect of Crystal Properties and Grain Sub-  
structure on the Strength of Metals

**PERIODICAL:** Metallovedeniye i termicheskaya obrabotka metallov,  
1961, No. 9, pp. 33 - 43

**TEXT:** An analysis is presented of experimental results,  
published in recent years both in the Soviet Union and abroad,  
with the object of elucidating the basic structural factors  
determining the strength of metals. It is shown that although  
distortions of the second type (lattice distortions) hardly  
affect the resistance of metal to deformation, they characterise  
the relative properties of the crystals of a given substance  
which, in turn, affect resistance to deformation. The effect of  
various mechanical and thermal treatments on hardness, the  
dimensions of blocks and the magnitude of  $\Delta a/a$  in Fe-Si alloys  
are discussed as well as the temperature-dependence of the yield  
point and UTS of preliminarily quenched and annealed  
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On the Effect of Crystals ....

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in cold-worked specimens.

3) Alloying can bring about a change in the temperature-dependence of both sub-structure stability and crystal properties. If alloying is to increase the high-temperature strength of a metal, both factors must be changed in the favourable direction: thermal stability of the sub-structure must be increased and the rate at which the resistance of crystals to elementary acts of plastic deformation decreases with rising temperature must be reduced.

There are 10 figures and 24 references: 16 Soviet and 8 non-Soviet. The four latest English-language references quoted are: Ref. 12 - W.G. Jonston, J.J. Gilman - "Journ. Appl. Phys.", v.70, No. 2, 1959; Ref. 19 - A. Cottrell - Trans. of the Metallurg. Soc AIME, V. 212, 1958; Ref. 20 - D.F. Stein, J.R. Low - Journ. Appl. Phys., Vol.31, No. 2, 1960; Ref. 24 - W.C. Jouston, J.J. Climán - Journ. Appl. Physics, V.31, No. 4, 1960.

ASSOCIATION: T<sub>5</sub>NIICHM

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188200 1418,1555

21366  
S/126/61/011/004/016/023  
E193/E483

AUTHORS: Kardonskiy, V.M., Kurdyumov, V.G., Kurdyumov, G.V.  
and Parkas, M.D.

TITLE: The Effect of the Grain Substructure and Crystal  
Properties on Strength. I. The Fe-Ni and Fe-Si Alloys

PERIODICAL: Fizika metallov i metallovedeniye, 1961, Vol.11, No.4,  
pp.609-614

TEXT: The object of the investigation described in the present paper was to study the effect of the thermally induced variation of the properties of crystals on strength of metals in the hard condition and on the magnitude of the elastic deformation of microdomains (distortions of the second type). The experimental work was carried out on two Fe-base alloys, one containing 25% Ni and the other 1.15% Si. (The Ni-bearing alloy was chosen for this purpose because of its specific characteristic, consisting in that annealing of this alloy at 450°C brings about a complete removal of the distortions of the second type without significantly affecting the size of the regions of coherent scattering.) The Fe-Ni alloy was hardened by quenching, the Fe-Si alloy by cold rolling to 50% reduction in thickness. In addition to the determination  
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The Effect of the Grain ...

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(by X-ray diffraction analysis) of the magnitude of distortions of the second type,  $\Delta a/a$ , and the size  $D$  of the regions of coherent scattering, the yield point ( $\sigma_s$ ), U.T.S. ( $\sigma_B$ ) and Vickers hardness number (HV) of both hardened and partially annealed alloys were measured, and the temperature-dependence of these properties was determined for both hardened and fully annealed specimens. The results of the first series of experiments, carried out on preliminarily hardened Fe-Ni alloy, are reproduced in Fig.1, where HV,  $\sigma_s$  (kg/mm<sup>2</sup>),  $D$  (10<sup>-6</sup>, cm) and  $\Delta a/a$  (10<sup>-3</sup>) are plotted against the annealing temperature (°C); in addition, the diagram shows the temperature-dependence of HV and  $\sigma_s$  (curves, marked HV(t) and  $\sigma_s(t)$ , respectively). It will be seen that the temperature dependence of  $\sigma_s$  and HV is quite different from the relationship between these properties (measured at 20°C) and the annealing temperature. Thus,  $\sigma_s$  measured at 450°C is 25 kg/mm<sup>2</sup> lower than  $\sigma_s$  measured at 20°C after annealing at 450°C, the corresponding difference for HV being 90 units. On the other hand, the temperature-dependence of  $\sigma_s$  and HV is almost identical with the relationship between  $\Delta a/a$  and the annealing temperature. The fact that  $\sigma_s$  of preliminarily

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# The Effect of the Grain ...

hardened specimens is practically constant after annealing at various temperatures indicates that  $\sigma_s$ , measured under these conditions, reflects mainly the character of the variation of the grain substructure during heating; in fact,  $D$  of specimens, annealed at various temperatures, also remains practically constant (see Fig.1). In the next series of experiments, preliminarily hardened specimens of the Fe-Ni alloy were annealed at 430°C to attain almost complete removal of the distortions of the second type, and then the temperature dependence of  $\sigma_s$  of these specimens was determined. This was found to be identical with that of fully hardened alloy, whereby the view was confirmed that the resistance of an alloy to deformation is not increased by the presence of distortions of the second type. Owing to the comparatively low temperature at which the reverse  $\alpha \rightarrow \gamma$  transformation takes place in the Fe-Ni alloy, it was not possible to use this material to study the relationship between  $\Delta a/a$  and the temperature dependence of annealed specimens. For this purpose the Fe-Si alloy was more suitable. The results of experiments carried out on this material are reproduced in Fig.4 which shows: temperature dependence of HV of cold-rolled alloy

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## The Effect of the Grain ...

(curve HV(t), white triangles); temperature dependence of HV of specimens annealed at 750°C (curve HV(t), white squares); variation of HV of preliminarily hardened specimens after annealing at various temperatures (curve HV, white triangles); variation of  $D$  (dots) and  $\Delta a/a$  (white triangles) after annealing at various temperatures. The temperature dependence of HV of the annealed specimens reflected the decrease in the resistance of the alloy to deformation due to the variation of the properties of crystals with rising temperature; since the specimens were annealed at 700°C, their grain substructure should remain unchanged during subsequent heating and should not affect the variation of HV. In the case of the cold-rolled specimens, whose HV was measured at room temperature after annealing at various temperatures, the variation of HV reflected only the changes in the micro- and sub-microscopic structure of the grains, brought about by heating to progressively higher temperatures. This means that in the temperature dependence of HV of cold-rolled material, HV at each temperature should be determined by the changes in both the grain substructure and the crystal properties that have taken place as a result of heating to this

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The Effect of the Grain ...

temperature. Starting from these considerations, the present authors constructed a "theoretical" curve, illustrating the temperature dependence of HV of cold-worked alloy, simply by adding (for each temperature) the decrease in HV due to the change in the crystal properties (found from the experimentally determined temperature dependence of annealed specimens) to that due to the variation of the grain substructure (found from the experimentally determined variation of HV of cold-worked specimens after annealing at various temperatures). The results plotted in Fig.4 (black triangles) were in good agreement with the experimental curve (white triangles). The results of the present investigation confirmed the view that strength (resistance to deformation) of a hardened material is determined by two factors: (1) the properties of the crystals (resistance to the movement of dislocations in the crystal regions, free from sub-boundaries) and (2) the substructure of the crystals (size of the sub-micro-regions, presence of sub-boundaries, degree of misorientation of the mosaic blocks). There are 5 figures and 9 Soviet references.

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